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A Method for Estimating Future Volumes of Partially Cut Stands in the Southern Appalachians

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In deciding when and how to make partial cuttings leading toward the sustained yield management of forests, some knowledge of the growth rate to be expected of the stands left is exceedingly important. No one has yet found out how to make precise growth forecasts applicable to all of the many forest types and conditions to be found in the Southern Appalachians. Later on, as management proceeds, such forecasts will become available for individual tracts. In the meantime there will be need for such generalized information as can be supplied, and the method here described is therefore presented as a provisional means of estimating the future growth of stands left after partial cutting.

The method is based on diameter tallies of the trees left on cut-over lands, arranged in groups of species. The field data on which they are based were collected in Western North Carolina and Northern Georgia by the Appalachian Forest Experiment Station in the autumn of 1934. Volume measurements and increment borings were made on 60 fifth-acre sample plots in stands partially cut 6 to 35 years ago and unburned since logging. Nine of these plots were cut less than 10 years ago; 39 were cut between 11 and 20 years ago; and 12 between 31 and 35 years ago.

Sixty-five per cent of the plots represent stands in which the trees were intentionally left for future growth. On the other tracts sampled, any desirable growing stock present was left because it was unmerchantable at the time of logging.

The trees on the plots were tallied by groups of species (see Table 1) based on similarity of growth rate and form. Group I contains the species of most rapid growth and Group III, those of least rapid growth. The species in Group I fall in one form class, while those in Groups II and III belong in another. These groupings, determined from growth data available at the station and on a comparison of volume tables, were decided before field work was started. The groups of species are so arranged that by considering the number of trees in

each group, differences in types are automatically taken care of. The tables presented below are consequently applicable to all Southern Appalachian hardwood types. White pine and yellow pine, although not present on any of the plots studied, are sometimes found in hardwood types. Presumably they can best be included in species Group I.

How to Use the Tables:

1. Make a cruise of the cut-over area, within one growing season following the logging. Tally the good trees (as defined below) 6 inches d.b.h. and larger by inch classes 1/, and according to the three species groups shown in Table I.

Good Trees are those that are likely to live through the period for which the final volume or growth is to be estimated. Omit from the tally trees that are broken and stag-headed, those that have flat crowns, or crowns of poor vigor (thin and with leaves of poor color), and those that are likely to become culls because of crook or rot.

The plots selected for the cruise should be evenly distributed over the cut-over area. The greater the percentage of the area covered by plots, the more reliable will be the results.

The most accurate results may be expected if the tallies are kept separate by fifth-acre sample plots (plots 1 chain wide by 2 chains long) and the future volumes computed for each individual sample plot, as was done in the field work upon which the tables are based. However, if conditions are fairly uniform on all of the plots, all the cruise data may be lumped together and one determination made. Stands with widely varying average diameters should not be grouped together.

2. Compute the average diameter for each species group to the nearest tenth-inch. Multiply the number of trees in a diameter class by the middle diameter of the class (6 is the middle diameter of the 6-inch class; 7, of the 7-inch class, etc.), and divide the sum of the products thus obtained for each group by the total number of trees in the group. The result will be the average diameter for each species group.

3. For each species group read from Table 1 the average volume per tree opposite the proper average diameter and under the number of years for which the prediction is to be made. Where the average diameter is not a whole number, interpolate to the nearest tenth inch in the diameter column.

4. Multiply the average volume per tree by the number of trees in the species group. The result is the volume for the whole species group.

1/ The 6 inch class includes trees above 5.5 inches and below 6.5 inches; the 7, above 6.5 and below 7.5 inches, etc.

TABLE I

Data for Estimating Future Board Foot Volume of Partially Cut Stands of Appalachian hardwoods.

SPECIES GROUP I

Yellow Poplar, Basswood, Cucumber, Hemlock, Black Cherry, (Yellow pines, White Pine)

Average d.b.h. of good trees at time of cut (Inches)	Years after Cut: 0*	5	10	15	20	25	30
	Average volume at end of period per good tree left at cut (Board Feet Scribner)**						
6	0	0	24	60	100	141	183
7	0	17	47	84	125	167	210
8	5	38	70	107	150	195	239
9	21	60	94	134	177	223	268
10	42	83	118	160	204	251	298
11	67	107	145	189	232	280	328
12	94	134	173	217	261	310	359
13	125	164	204	248	293	341	391
14	161	198	237	281	326	373	422
15	203	239	275	317	359	404	455
16	252	283	318	357	396	439	490
17	304	331	365	400	434	475	523
18	361	388	416	445	475	512	557

SPECIES GROUP II

Black, Scarlet and Red Oaks, Birch, Ash, Sugar Maple, Black Locust

Average d.b.h. of good trees at time of cut (Inches)	Years after Cut: 0*	5	10	15	20	25	30
	Average volume at end of period per good tree left at cut (Board Feet Scribner)**						
6	0	0	0	1	20	61	102
7	0	2	6	19	45	83	122
8	6	13	24	43	72	107	146
9	15	27	46	69	98	135	175
10	29	46	67	95	128	166	207
11	45	67	92	123	160	200	241
12	67	94	121	157	195	236	276
13	95	126	159	194	232	272	312
14	130	165	199	236	272	311	350
15	170	208	245	281	314	352	389
16	215	259	295	332	365	397	428
17	266	313	352	387	418	445	475
18	321	372	415	448	477	500	525

TABLE 1 (Continued)

SPECIES GROUP III

White, Chestnut and Southern Red Oaks, Hickory, Beech, Buckeye, Black Walnut

Average d.b.h. of good trees at time of cut (Inches)	Years after Cut: 0*	5	10	15	20	25	30
	Average volume at end of period per good tree left at cut (Board Feet Scribner)**						
6	0	0	0	0	5	11	22
7	0	2	6	13	23	37	54
8	5	11	22	35	50	70	90
9	17	26	41	60	82	105	134
10	35	44	62	85	113	147	185
11	54	66	85	111	146	192	241
12	75	90	110	139	178	236	301
13	98	115	137	169	212	282	367
14	124	144	167	200	250		
15	152	175	200	235	290		
16	185	210	239	274	335		
17	220	249	282	321	386		
18	261	297	335	377	447		

*----From this column the volume left immediately after the cutting may be figured. The difference between the volume at the end of any period and this volume left immediately after the cutting is the growth during the period.

**---Volumes shown are for trees 12 inches d.b.h. and larger, Scribner rule. They are figured to an 8 inch top diameter. In common woods practice a variable top diameter, equalling approximately 75% of d.b.h. is used. The volumes given here must be reduced approximately 20 per cent to make them conform to this practice.

Allowance was made for defect.

Volumes of trees growing into the 12 inch d.b.h. class during the period are included.

5. Add the estimated volumes found for the individual species groups. The result will be the total volume for the area tallied. When greater accuracy is sought, and the field data have been kept separately by fifth-acre plots, the volume to be expected for each plot must be computed separately and the results added to find the total for the area tallied.

6. To determine the volume per acre, divide the figures obtained under Step 5 by the number of acres tallied. Multiply this result by the number of acres in the cut-over tract. The result will be the total volume for the area.

A Comparison of Measured Growth With Estimated Growth:

Data from five one-acre permanent plots established by the Station in a stand partially cut 10 years ago afford a check on the accuracy of Table 1. The volume actually measured 10 years after cutting was compared with that estimated by applying the table to the residual stand left after the logging, which was made up entirely of good trees. The error for the five plots combined was found to be 7 per cent.

Example of Use of Tables to Estimate Volume and Growth:

The volume to be expected 25 years hence on 430 acres of Appalachian hardwoods, partially cut within the past year, has been computed as follows:

1. Following the logging, which removed approximately 7,000 board feet per acre, a 2 per cent cruise of the tract was made. Fifth-acre plots were located at 10 chain intervals along lines run 10 chains apart. Since the stand was uniform over the whole tract, the tallies on the 43 plots were combined. Table 2 shows in Columns 2, 4, and 6, the number of good trees 6 inches d.b.h. and larger in each of the three species groups in the 8.6 acres in the 43 plots.

2. The average diameter of the trees tallied in each species group was then computed. For Groups I to III, the average diameters are 12.1, 11.5, and 12.4 inches. The number of trees on the 8.6 acres in the three groups in order are 92, 52, and 79.

3. From Table 1, the average volume per tree at the end of 25 years was read opposite the proper average diameter for each of the three species groups. In all three cases interpolation was necessary. The average volume per tree for the three species groups in order are: 313, 218, and 254 board feet.

4. The average volume per tree was multiplied by the number of trees to determine the volume of each species group on the 8.6 acres. These volumes are: Group I, 28,796 bd.ft.; Group II, 11,336 bd.ft.; and, Group III, 20,066 bd.ft.

5. The sum of the values for Groups I to III is 60,198 board feet, the volume of all species on the 8.6 acres at the end of 25 years.

TABLE 2

Tally, made immediately after logging, of good trees left on 8.6 acres of partially cut Appalachian hardwoods, showing method of predicting volumes at end of 25 years, and growth during the period.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Column Numbers					
	SPECIES GROUPS					
	I		II		III	
DBH Class	No. of Trees	col. (2) x (1)	No. of Trees	col. (4) x (1)	No. of Trees	col. (6) x (1)
6	12	(72)	9	(54)	4	(24)
7	11	(77)	4	(28)	5	(35)
8	6	(48)	4	(32)	5	(40)
9	5	(45)	3	(27)	7	(63)
10	2	(20)			8	(80)
11	9	(99)	4	(44)	9	(99)
12	13	(156)	6	(72)	5	(60)
13	1	(13)	4	(52)	6	(78)
14	4	(56)	4	(56)	3	(42)
15	3	(45)	3	(45)	7	(105)
16	3	(48)	7	(112)	4	(64)
17	7	(119)	2	(34)	6	(102)
18	7	(126)	1	(18)	3	(54)
19	1	(19)			4	(76)
20	4	(80)			3	(60)
21						
22	3	(66)	1	(22)		
23	1	(23)				
Total	92	(1112)	52	(596)	79	(982)
Av. Diam.	12.1		11.5		12.4	

Board Foot Volume 25 years After Cut

SPECIES GROUPS			Total	
I	II	III	8.6 Acres	Per Acre
Per Tree				
313	218	254		
For Species Group				
28,796	11,336	20,066	60,198	7,000

Volume on 430 acres at end of 25 years = 3,010,000 board feet.

6. The volume per acre at the end of 25 years equals 60,198 board feet, divided by 8.6, or 7,000 board feet. The volume on the whole tract is 3,010,000 board feet.

Use of Tables in Comparing Probable Results of Different Cutting Methods:

In the above example, there had been left the small merchantable trees on which there would be little profit if cut, and which were also of a size when volume growth is the most rapid. Also, a few of the larger trees had been left for quality increment. The growth of this stand as estimated by the above method for five year periods is compared in Table 3 with the growth of the same stand if all the trees 12 inches and above had been cut

Table 3

Volume of a stand of Appalachian hardwoods following partial cutting, and following removal of all trees 12 inches d.b.h. and larger.

	Years Since Cut						
	0	5	10	15	20	25	30
	Volume per acre at end of period (Board Feet Scribner)						
Partial cut (Stand left, shown in Table 2)	2,148	2,866	3,632	4,583	5,659	7,000	8,429
All merchantable trees, 12 inches d.b.h. and larger cut	112	340	597	921	1,320	1,756	2,222

If, as in the above example, some of the trees 12 inches d.b.h. and larger were left, a second cut, removing 3,000 to 4,000 board feet per acre and leaving 2,000 to 3,000 feet, could be made in 20-25 years. Approximately the same volume would be left in the second as in the first cut, to grow for a third cut. On the other hand, if all of the trees 12 inches and above had been cut it is likely that it would be 40 or 50 years before another cut could be made. In addition to producing enough volume for a cut in 20-25 years the area will be growing a larger volume of timber per acre than if the small merchantable trees had been cut. Also, a part of this volume is being put on larger trees, thus producing higher quality timber.

It must be remembered that these estimates are the volumes to be expected <u>if the area is not burned</u>. Considerably less volume can be expected if the area burns over.

In general, in making a partial cutting the good, small merchantable and the good smaller trees of desirable species should be left. All of the poor trees of undesirable species, of poor form, or of poor vigor that are

crowding the good trees, or that are occupying considerable space that might be used for new trees should be cut.

It is probable that the growth of an area can be increased over that shown in Table 1 by careful selection of the trees to be left and removing at least part of the undesirable trees.